Additionally, ethylene seems involved in stimulating the formation of a highly aerenchymatous root system. These adaptations enable the flooded plant to reach the water surface and aerate the submerged tissues, both leaves and roots.

The changes in ethylene concentration and production during submergence are very fast: an accurate high resolution technique is a prerequisite for research. Therefore, an extremely sensitive laser-driven photoacoustic cell, combined with a flow-through system, was applied. It proved possible to measure ethylene concentrations as low as 0·006 ppb, or production rates as low as 10 pl h^{-1}. Because measurements take place continuously, changes in ethylene concentrations or production rates can be detected within minutes.

Ethylene and Flooding Resistance. III. The Role of Ethylene in Shoot Elongation of *Rumex* Plants in Response to Flooding

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Rumex spp. that occur in the lower parts of Dutch river forelands can survive partial or even total submergence for weeks. This resistance may be explained by physiological and morphological adaptations, such as rapid shoot elongation. This process is regulated by the gaseous hormone ethylene. The release of this hormone can be continuously measured with a very sensitive laser-driven photoacoustic detection system. During waterlogging or submergence, flooding resistant *Rumex* plants show an increased ethylene production rate. Also an accumulation of the hormone within the plants occurs, especially during total submergence, due to the 10 000-fold slower diffusion of gases in water compared to air. This results in a high internal ethylene concentration, which causes a rapid shoot elongation response. In this way contact with the atmosphere can be restored. *Rumex* spp. that occur in higher rarely inundated parts of the river forelands are sensitive to flooding, and do not show this rapid shoot elongation response.

Interactions between Electron Transport Pathways in Potato Callus Mitochondria

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Mitochondria isolated from potato tuber callus (*Solanum tuberosum* cv. Bintje) contain a cytochrome pathway and an induced cyanide-resistant pathway for quinol oxidation. Both pathways function in respiration not only with succinate or malate as substrate, but also with cytoplasmic NADH or NADPH as substrate. The kinetics of this branched respiratory chain were studied experimentally with a Q-electrode during titrations of succinate respiration in purified potato callus mitochondria with an inhibitor of a quinol-oxidizing pathway (myxothiazol), inhibiting the cytochrome pathway, and an inhibitor of the quinone-reducing pathway (malonate), inhibiting succinate dehydrogenase. Titration experiments with *malonate* show that in state 3 a linear dependence is obtained between the redox state of the Q-pool and the respiration rate. In state 4 the dependence is non-linear, probably due to engagement of the cyanide-resistant pathway. Respiration activity of the cyanide-resistant pathway is only obtained at high reduction levels of the Q-pool (>80%). Measurements of the respiratory rate and the reduction of the Q-pool in titration experiments with *myxothiazol* show a more or less linear dependence of the rate on the redox state of the Q-pool in both states.

The obtained kinetic characteristics of the enzymes are used for further theoretical study of the branched respiratory pathway in potato callus mitochondria, using a model for the kinetics of the Q-pool. In this model the behaviour of the complete system is derived from the kinetics of the individual enzymes.

Effect of Nitrate on the Proton Gradient and Membrane Potential of the Tonoplast Membrane of Lettuce

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For many plant species nitrate is one of several solutes that accumulate in the vacuoles to maintain cell turgor. Accumulation of nitrate in the vacuoles may rise to high concentrations (up to 100 mM) and is inversely related to the concentration of organic acids.

Vacuoles already contain a large proton gradient after isolation, but they do not have a membrane potential. In this condition they do not take up nitrate. Influx of nitrate in the vacuoles is only possible when a membrane gradient is generated at the expense of ATP. Indeed, nitrate uptake is stimulated by ATP. This indicates a coupling between nitrate and ATPase.

Nitrate also inhibits ATPase activity, as shown abundantly in the literature. However, nitrate can